Evolving Ground System Engineering Practices to Meet the Needs of Future Space Missions

Ground System Architectures Workshop
Los Angeles, CA
February 28, 2012

Kathleen Crean, Oleg Sindiy, Patricia Lock, Brian Giovannoni
Jet Propulsion Laboratory / California Institute of Technology

Kevin Bonanne
Purdue University

Need & Motivation

- Introduction:
  - Ground System (GS) Engineers apply multi-mission ground system tools and processes to flight projects, customizing them as necessary
  - This work is performed by engineers with 15-20 years of experience
  - Gaps in their expert knowledge can lead to gaps in the design
  - Knowledge capture, retention, & dissemination is essential, yet difficult

- Task need & motivation:
  - Procedures describing ground system engineering practices and related products at JPL were found to lack:
    - granularity: insufficient guidance in descriptions of procedural activities, including expected input & output products and supporting activities
    - traceability: between and among activities and products
    - clarity: in delineation of the roles of, and relationships between, actors' work; in expected content and presentation of the products
    - consistency: in lexicon, GS architecture description, procedures presentation

Approach & Benefits

Approach: apply model-based engineering techniques for improved GS procedure & product description

- *This work is part of a larger, longer-term effort at JPL to revitalize GS engineering processes & products using model-based engineering techniques*

Key expected benefits:

- better knowledge capture & dissemination among the current system engineers
- clearer and more efficient communications among GS stakeholders
- identification and reduction of overlapping efforts in GS architecture development and deployment, resulting in cost and schedule savings

Roadmap to Achieve A Vision: Model-Based Approach for Ground System Engineering

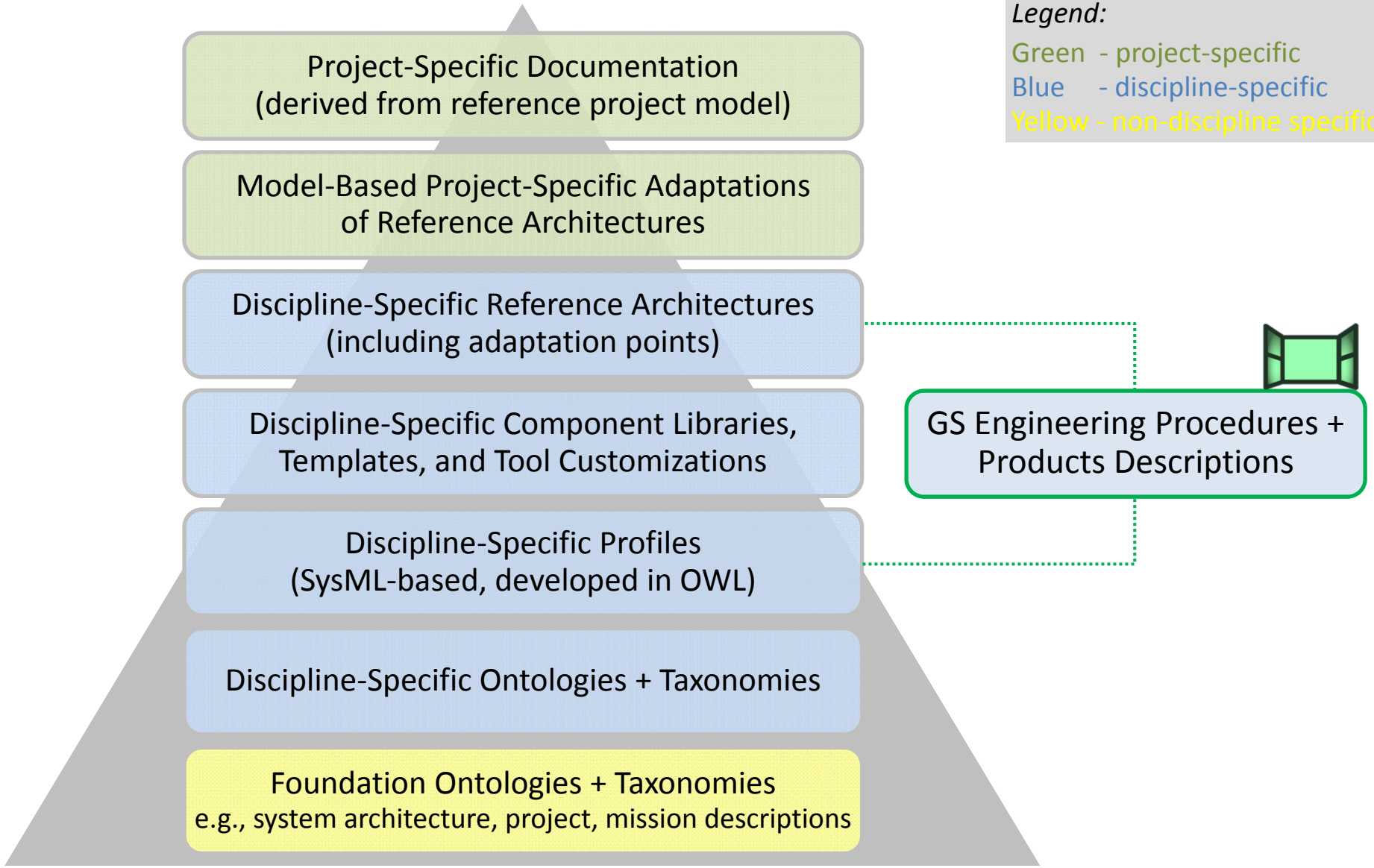
This requires creation of the following:

- Discipline-specific taxonomy and ontology; implemented as a SysML profile
- Reusable, model-based libraries for standard representation of viewpoints and products used to describe the various components of a GS
- Standard model organization/structure definition for GS architecture design, development, & deployment for use across multiple classes of projects
- Reference GS architectures, which builds on the above items
  - including adaptation points (and guidance) for project-specific uses of the framework
  - e.g., Earth orbiter, planetary orbiter, planetary lander, etc.

Implementation Step:

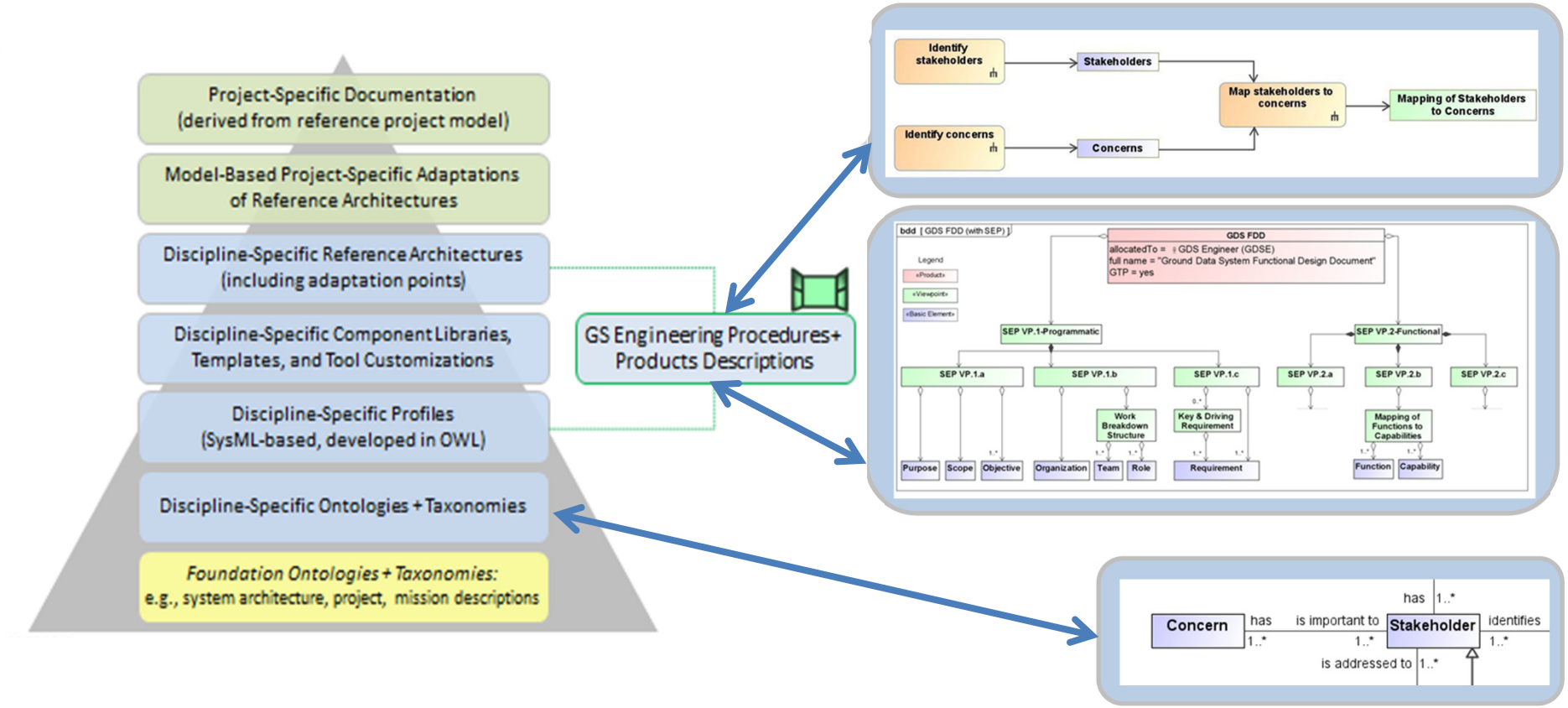
- Application of reference, model-based GS architectures to new projects/tasks, *with support from the guiding GS procedure & product descriptions*

Layered View of Assets that Procedures Would Point To



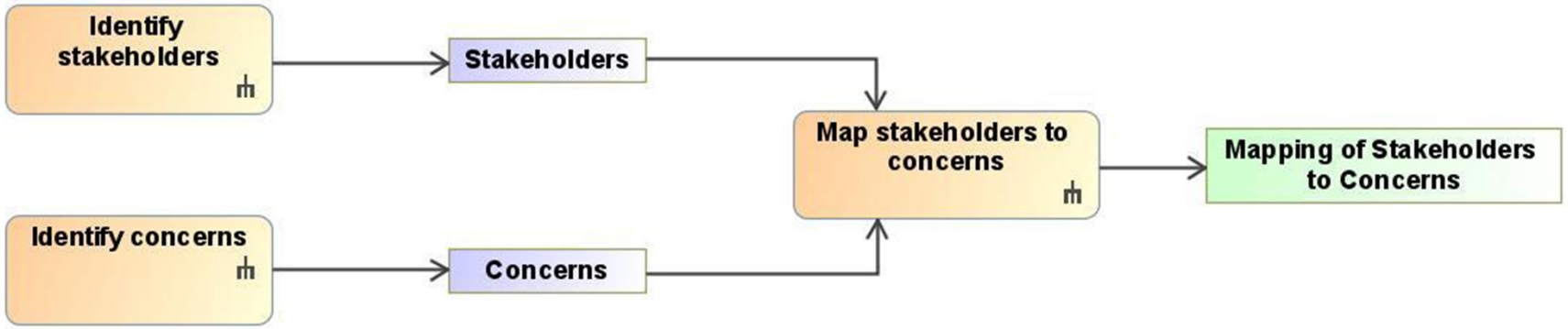
Example of Model-Based Implementation of Assets

Legend:
Green - project-specific
Blue - discipline-specific
Yellow - non-discipline specific



Model-based Engineering for GS Procedure & Product Description Capture

Actors	Phase A - Activities
Ground Data System Engineer	3.1 Work with, as applicable, the Mission Manager, GDS Manager, & Mission Operations System Engineering to: a. identify stakeholders (e.g., users & customers), and map to, and analyze their concerns (e.g., needs)



Concluding Remarks

Currently:

1. Modeling existing procedures & products involved in JPL GS development & deployment
2. Leveraging state-of-the-art practices for model-based engineering
   - representation & relationship capture: SysML, OWL, etc.
   - employing a commercial modeling tool: MagicDraw
   - IEEE Standard 1471 for architecture description taxonomy
   - building upon existing institutional ontologies & taxonomies
   - starting to capture of discipline-specific ontologies & taxonomies

Future:

- Complete & publish updated GS engineering procedures
- Use the updated procedure & product descriptions to:
  - update training & cost models
  - improve consistency and guide expectations for reviews
  - provide guiding representations for expected views in products; i.e., viewpoints library
  - employ models to generate improved GS products—via use of discipline-specific component libraries, templates, & tool customizations
- Coordinate with other synergistic model-based efforts at JPL
  - existing institutional efforts at JPL: Integrated Model Centric Engineering (ontologies); SS-CAE (tools)
  - other program and project efforts: MGSS – Operations Revitalization task, etc.; JEO-EHM